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A comparison of calibrated sap flow and MAESTRA model simulation estimates of tree transpiration in a Eucalyptus plantation

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Abstract

We examined the ability of the MAESTRA model, a three dimensional model of individual tree transpiration, to capture the seasonal and within-stand tree water-use variability in a fast-growing eucalyptus plantation. MAESTRA was parameterized using data from in situ measurements on tree organs. To capture within-stand variability in tree size, sap flow measurements were taken on 15 trees that spanned the range in aboveground biomass (16.3 - 346.2 kg) and leaf area (2.1 - 90.1 m²) in a 6 year old southeast Brazil Eucalyptus grandis plantation. Transpiration simulation predictions were compared to estimates from sap flow measured by the thermal dissipation method calibrated at the whole tree (potometer) and stand (eddy covariance) level. Calculated transpiration showed a significant relationship to measured transpiration ($R^2=0.79$, $p<0.0001$, Figure 1). During the study, measured and simulated transpiration rates ranged from 2.6 to 92.7 L day⁻¹ and 2.1 to 110.4 L day⁻¹, respectively, whereas mean maximum and minimum temperature were 20.3, 33.2 and 16 oC, respectively, and total precipitation was 1148mm. Seasonal differences between measured and modeled maximum (46.5 versus 65.7 L day⁻¹), mean (30.7 versus 34.1 L day⁻¹) and minimum (17.6 versus 16.1 L day⁻¹) transpiration were small. Specific to within-stand variability in tree size, MAESTRA underestimated the transpiration of small trees (leaf area < 15m²) by 8% and overestimated large trees (leaf area > 45 m²) by 9%. This work quantified the accuracy of the MAESTRA model to estimate seasonal patterns of Eucalyptus grandis forest plantation transpiration. Hence, MAESTRA can assess the consequence of Eucalyptus grandis production on the hydrologic resources of the region.

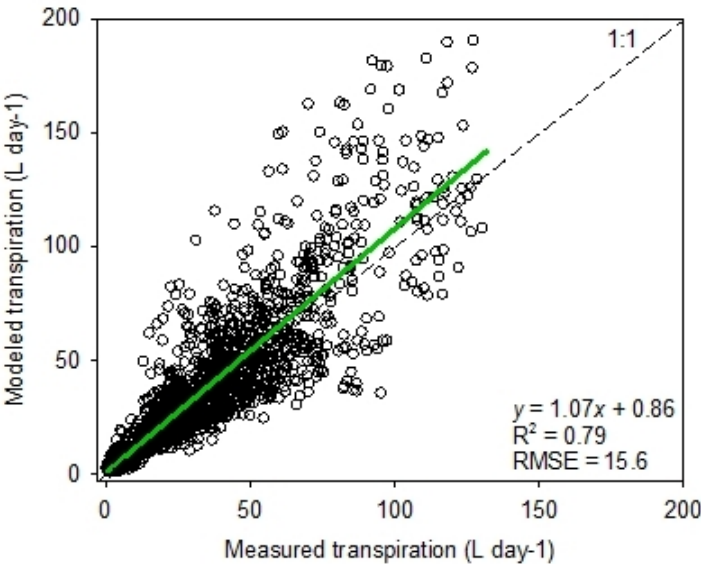


Figure 1. Relation between measured and modeled transpiration rates for all trees and days. Dashed line represents 1:1 line.

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